

it simply slinks away just out of reach of the murderous hoof and returns again to its nest, quite unperturbed, immediately the danger has passed.

In conclusion, I note that it is stated in the *Fauna of British India* (Birds) that the adult breeding Ibis-bill has blood red feet and legs but, on both the occasions on which I have seen them at their nests, their feet were a livid and greenish grey colour, the colour assigned to non-breeders. Though the rule laid down may not be infallible, yet it is possible that I had observed the same pair breeding again, nesting on a site only seventy yards removed from that of a former nest used four years previously, perhaps this is an example of the unerring instinct shown by migrating birds in their return year-in, year-out, to their same chosen breeding haunts.

TROUT OF TRAVANCORE.

BY

W. S. S. MACKAY.

WITH A FOREWORD

BY

H. A. RAGG.

(with 2 plates)

*'Of recreation there is none
So free as fishing is alone;
All other pastimes do no less
Than mind and body both possess;
My hand alone my work can do,
So I can fish and study too.'*

The Angler's Song, 1653.

FOREWORD

It is a great pleasure for me to write a foreword to Mr. Mackay's *Trout of Travancore* as I have been able to watch the results of various attempts to establish trout in the waters of the High Range over a period of thirty odd years. It was not until Mr. Mackay built the Rajamallay hatchery and later took over the stocking of the waters that success was attained.

The chapters describing the management of the hatchery and the disposal of the fry make very interesting and instructive reading.

The three outstanding factors which have been responsible for turning failure into success are, firstly, the very liberal help which has been given to the High Range Angling Association by the Directors of the Kanan Devan Hills Produce Company Limited, without which it would have been impossible to carry on with the work,

secondly, to Mr. Francis for his keenness and foresight in his 'Eruvikulam Policy' as it was very largely due to this scheme that failure was averted, and lastly to Mr. Mackay for his untiring energy, and keenness and for his excellent work in 'fair weather and foul'.

It is a great pleasure to anglers to wander up these lovely streams and to see the number and the size of the fish and to realise the money and energy expended have reaped their just reward.

H. A. RAGG

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INTRODUCTION

The Kanan Devan or the HIGH RANGE forms part of the system of hills and passes known all over the world as the Western Ghats, stretching from Poona to Cape Comorin. Although much of the country has now been opened up into tea, it has lost very little of its original grandeur, the highest land being quite unchanged.

Messrs. James Finlay & Company of Glasgow were granted a second concession of 200 square miles some 50 years ago, and amongst other beneficial innovations the stocking of the streams with trout, received their attention.

The first experiments were carried out as far back as 1909 but until the year 1939 no great success was achieved.

The country round which all recent experiments have been conducted lies in close proximity to Aneimudi, the highest peak south of the Himalayas, 8,841 feet above sea level. It was in the streams of Hamilton's Plateau lying north of Aneimudi that Rainbows were first found to be breeding, and it is on the slopes of this mountain itself that the present hatchery is situated.

It was suggested to us that we should write the story of trout culture in this part of Travancore before the early records available were finally lost in the passages of time. Indeed the work was started, and part of it appeared in the *Field* of March 1940. The final attempt to establish trout was inaugurated in 1937, and by 1944 success had at last been achieved.

Permanent success, however, still remains to be assured and the need for knowledge is acute. Though the black years are over, it is necessary to turn to the future, planning for several years ahead, and much study in relation to local conditions is required. It is in this way only that the angler can be satisfied and big baskets and a reasonable weight average maintained.

We hope the following pages will serve two important purposes, which are:—

1. To record our varying fortunes from the beginning, in such a manner that past mistakes cannot be repeated.
2. To stimulate interest and to educate the angling public to the magnitude of the tasks before them.

Without the co-operation of all anglers in the High Range these tasks would be impossible, but it is in the full assurance of that co-operation we submit this work.

We have to acknowledge with grateful thanks reference to Mr. Philip Fowke's work 'Trout Culture in Ceylon', and also to his many interesting and instructive letters. Also to Mr. W. H. Armistead's 'Trout Waters' and 'Practical's 'Fish Farming for Pleasure and Profit'.

I.—HOW TROUT BREED.

In ancient days in the British Isles, nature looked after the stocking of the rivers and lochs unaided. Indeed until the present century the proprietors of fishing waters had little or nothing to worry about, as there were no tar Macadam roads, cars making access to all water an easy matter, or new fangled methods and patent instruments, for taking fish. In accordance with individual conditions nature allows somewhere between 2% and 7% of the number of eggs laid by a fish in fresh water to hatch and mature, and in the good old days this was sufficient to stabilise the trout population at a reasonable level. But with the march of time and the steady decrease of stock, due to excessive fishing, netting, and poison discharged from factories, nature could no longer tackle the problem alone. In 1856 the difficulty was overcome by a Russian named Vrascki, but before we relate this fascinating story, it is necessary for us to consider how trout breed.

Trout breed during the coldest period of the year, and when they come into season they make for the upper reaches of the streams, or the burns draining into lochs, where cold clear running water is generally to be found, and where there are sandy banks and gravel beds. In company with several male fish, each struggling for her possession, the female or hen fish as she is called, makes her way up stream until she finds a suitable place for her nursery which is generally at the tail of a shallow run or pool. On the hen fish falls the work of constructing the nest or redd, and this she does by pressing herself against the stones and gravel, and moving a foot or so upstream, she excavates a hollow with powerful sweeps of her tail.

When the redd is complete the hen fish makes a new movement. Once more she passes up the redd turning from side to side. This time she is laying, and the male or cock fish following closely behind exhibits intense excitement, and drives away any smaller fish that may be in the vicinity. With each flash of her side the female sends out a single stream of eggs, which are heavy and sticky. Having laid a certain number she immediately passes to one side, to be at once supplanted by the male who passes over the eggs shedding his

milt as he goes. The fish then move off to another redd leaving the eggs to the mercies of their very numerous enemies. Several spawnings occur in a season before the spawners finally return to deeper water. A hen fish lays between 700 and 800 eggs for each pound of her weight, and in breeding no actual contact takes place between the sexes.

Now man had for many years studied and observed these operations, so at last when the necessity for experiments became essential, he commenced to breed trout by catching the wild spawners as they came to the shallow pools in the head waters, and stripping the eggs and milt into a basin of water, placed them in running water to hatch. A modicum of success was achieved, but an old gentleman called Seth Green, an American, began to produce astounding results. He was a dour old man and always kept his mouth tightly shut, so that when he departed this life his secrets went with him.

Until this time the work had been in the hands of practical men, gamekeepers no doubt, and men well acquainted with the ways of the woods and rivers, but now Vrasski, a Russian naturalist and scientist, began to make experiments using the microscope with which to examine the eggs and milt. He found that the eggs on stripping were sticky and adhesive, which is a provision of nature to guard against them being washed from the redds by a sudden increase in the flow of the water. He found the ova to be intensely absorbent, and that from the time they leave the fish they absorb water quickly until saturation point is reached.

He found the sperm of the male fish to be intensely active in water, but this activity soon ceased, the sperm becoming lifeless or in other words drowned. It was here that the secret of Seth Green was revealed, and taking a *dry* basin he stripped the eggs and milt into it discovering that now he could, without difficulty, obtain success, the milt coming into contact with all the eggs before losing its fertility. Later in this work the stripping of trout is dealt with in detail.

Despite the fact that Vrasski at once made his discovery known to the world at large, it was nearly a quarter of a century before it was accepted by the experts who were hatching trout in other countries. At last however the DRY METHOD of stripping ova was acknowledged, and in the Russian's honour it is popularly called the *Vrasski method* to-day.

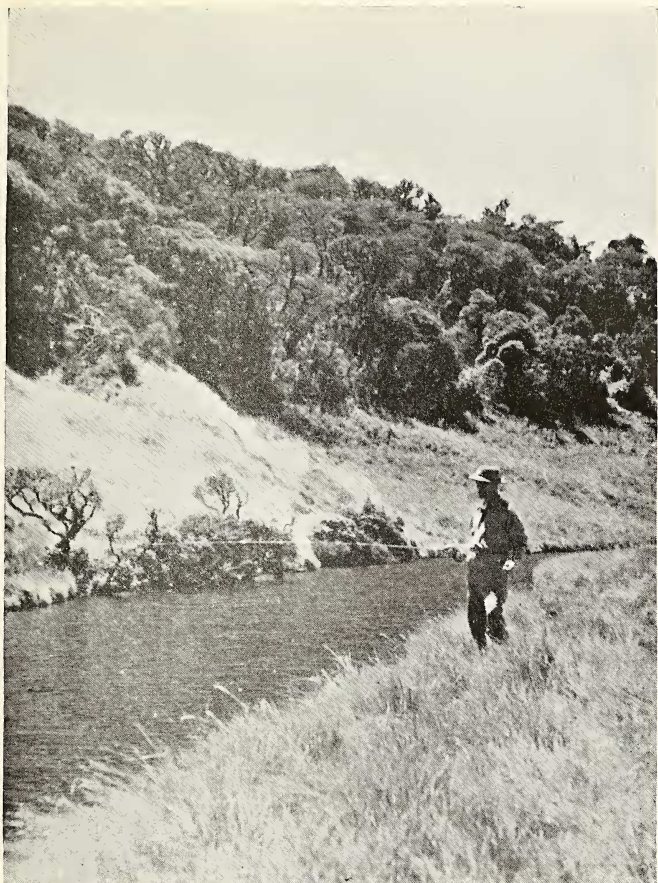
II.—THE FIRST EXPERIMENT WITH BROWN TROUT.

Transportation of Ova from Scotland.—The whole question of breeding trout is governed by temperature. In very cold countries eggs may lie in the hatching troughs for a hundred days. In the warmer climate of the High Range of Travancore the hatching period is reduced to 28 or 29 days. At an average temperature of 50° F. ova will hatch in 50 days, with a decrease of five days in this period, for every degree rise in the temperature. With the modern types of cold storage, it is possible to transport eyed or fertile ova, to almost any

part of the world. The ova is generally packed in moss and placed on trays, which are fitted into a square wooden box for local transport in India. The temperature is kept constant by the application of ice, but during transport by sea the box should have facilities for proper examination to allow for the removal of dead eggs, which are easily discerned as they turn white and show up well against the delicate pink of the healthy ones.

In 1909 four planters M. C. Koechlin, John Carless, 'Daisy' Bell and 'George' Howlett were discussing trout fishing in the bar of the High Range Club, as at that time great success was being recorded from Ceylon, and in the Nilgiris experiments had been going on since 1863. In 1906 the Nilgiri Game Association were fortunate enough to secure the services of an experienced pisciculturist, the late Mr. H. C. Wilson, who had shown that experiments with Scottish Brown Trout (*salmo fario*) were unsuccessful, because of the insuperable difficulty of the females being ready to spawn before the males were in season. He pinned his faith to the Rainbow trout (*salmo shasta*) or the Steelhead (*salmo irideus*) and it is believed imported ova from Insbruck, Austria, out of which nine trout survived. Later from New Zealand ova was obtained from which considerable success was achieved. A hatchery on up to date lines was constructed at Avalanche, where steady progress has been made from then, until the present day.

In the light of these successes the planters argued that there was no obstacle to successful operations of a similar character being carried out in Travancore, and they finally approached Mr. P. R. Buchannan, the General Manager of the Kanan Devan Hills Produce Company, for advice. Mr. Buchannan was a man of foresight and sagacity, and innovations of all kinds received his careful attention. It appears, however, that the experiences of the tyros in the Nilgiri Hills had not at that time been fully understood, for arrangements were made to import the eyed ova of Brown trout from the hatchery at Howieton in Stirlingshire. The first consignment was sent direct to Bombay where it was met by Philip Gouldsbury and successfully brought to the High Range. On another occasion a box containing 10,000 ova was duly delivered by the Howieton people into the charge of M. C. Koechlin returning from leave on board a ship sailing from Liverpool. No details are available of this particular voyage or of the difficulties experienced if any, but it is known that the operation was successful. In those days transport difficulties were considerable, so when the chest of ova arrived at Colombo it had to be transhipped to a coasting vessel bound for Tuticorin. In the absence of cold storage facilities aboard the coaster large supplies of ice had to be arranged for. At Tuticorin ice was required for the train journey to Kodaikanal Road Station, and lastly for the 75 miles drive by bullock cart to the bottom of the riding ghat, where the chest was taken over and carried by head load to Top Station, an elevation 6,200' above sea level. On one such expedition, the last of its kind, which was undertaken by George Strachan in 1913, the ice ran out uncomfortably far from his destination, but with good fortune, and by hurrying on the coolies, he succeeded in reaching the High Range safely, and a splendid success was achieved.



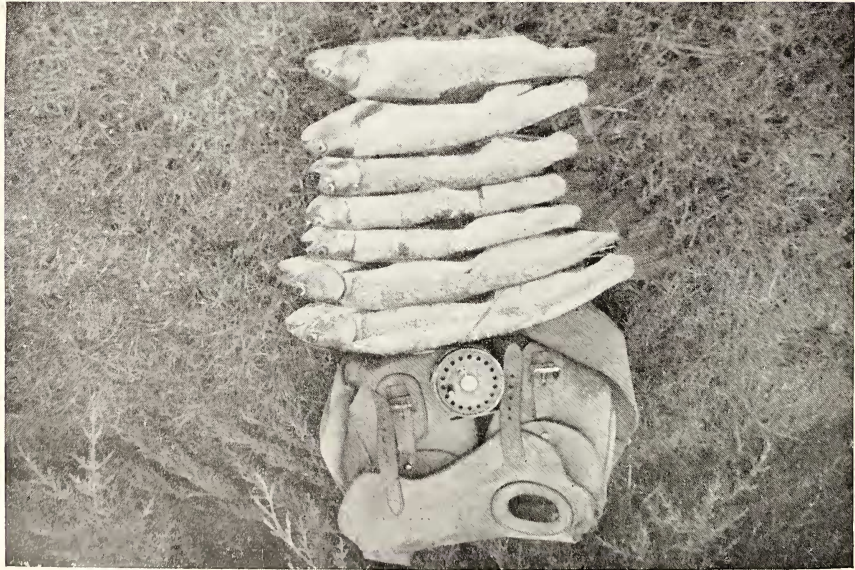
(1) Major J. R. S. Mackay at Eruvikulam where the first Brown Trout were caught about 1910.



(2) Upper Eruvikulam with Aneimudi in the background.



(3) Turner's Valley.



(4) The result of careful stocking.

in the interim period between the ordering of the first ova and its arrival in the High Range a small hatchery was constructed at Chundavurrai by John Carless who with the help of H. A. Ragg supervised the work in connection with the hatching of the ova.

The First Hatchery.—This hatchery was situated about a mile from the Chundavurrai factory. It was a simple enough affair, the water being led in from an open channel broken at several points by silt traps, to a distributing trough, from which two hatching troughs were supplied. The whole construction was of timber and the final filtration of the water was accomplished by fitting in wooden frames covered with towelling at the head of the troughs. In theory the system was adequate, but in practice somewhat unsatisfactory. All day and throughout most of the night a reliable overseer, which generally turned out to be one of the European Managers of a neighbouring Estate, was compelled to be in attendance, constantly changing the filters which had become clogged with dirt, and keeping an eye on the flow of the water. History does not record all the difficulties they overcame, but it is a matter of great credit to them that they succeeded in hatching a very reasonable percentage of the ova they had imported all the way from Scotland.

Between 1909 and 1914 at least 25,000 eggs were imported, and about 10,000 fine little trout were hatched out at Chundavurrai. When all the difficulties of transport in those days are considered, this percentage must be looked upon as remarkable. The work was undertaken without the aid of any informative literature regarding trout culture in the East such as we have to-day, or the help of such experienced men as would be readily available at home.

Early Stocking.—The trout bred at Chundavurrai were liberated in the Kundaly stream above where the new dam for the Power Scheme is now being constructed. These trout made their way down stream, but alas many of them fell into the hands of poachers who set nets and night lines in the vicinity of Madupatty Estate. Some were also liberated at Kanniamallay and Guderale and J. M. Bridgman and E. H. Francis stocked the Othaparai stream, but few of these fish were seen again. Trout were taken to the wilds of Hamilton's Plateau and were liberated in the Eruvikulam river by A. W. John and a fellow planter, and these trout did exceedingly well. As far as we know no natural breeding of Brown Trout took place in this or any other High Range water.

The records of trout caught are unavailable. It is known that several magnificent fish were taken at Eruvikulam by 'Clan' Fraser and that a trout weighing $3\frac{1}{2}$ lbs. of which there is a cast in the High Range Club, was caught on a worm near Perivurrai by M. C. Koechlin. The honour of catching the first Brown Trout however probably fell to Henry Gribble Turner, and this is how it occurred.

H. G. Turner's name is closely associated with the discovery of the Kanan Devan Hills, or the High Range, which he first came upon at the end of a lengthy 'shikar' expedition. He and his half brother, A. W. Turner, later formed a Company styled the North Travancore Agricultural and Planting Society, to whom a concession of 200 square miles was given 'and to their heirs and successors for ever'. Messrs. James Finlay and Company took over this Plant-

ing Company in the year 1896 and formed the Kanan Devan Hills Produce Company Limited. The land consists of high grassy peaks and plateaux, and the valleys which break up the country from end to end, were clothed with dense forest. Most of these valleys have now been opened up into tea, but the higher land remains much as it was a thousand years ago. H. G. Turner, who was a servant of the Government of Madras, was on the eve of retirement when he experienced a desire to revisit, for the last time, the hills he loved so much. In company with an old friend, 'Toby' Martin, another pioneer of the District, who was at that time in charge of Labour Recruiting at Bangalore, he camped out in the wild country of Hamilton's Plateau, in the vicinity of Aneimudi. One evening as they sat on a ridge above the head waters of the Eruvikulam river, on the look-out for a herd of Bison, they were astonished to see through their glasses unmistakable rings, apparently made by trout rising, in the still part of the river. They had no idea that any trout had been put into this river, and it was only then that they understood from the hillmen with them, that trout stocking operations had taken place the previous year.

The frequent and determined rises must have been altogether too much for these old warriors, for they at once proceeded to cut suitable lengths of cane from the forest with which to make a rod. The hook they fashioned from an old safety pin, and then all the lengths of string that could be collected from amongst their camp kit were joined together, a few grass hoppers were captured, and there they were ready for an experiment in dapping.

There was a high wind ruffling the water when they reached the bank, and every now and then, particularly in the vicinity of the wild Rhododendron bushes that overhang the banks, there would be the 'plop' of a considerable trout. Gathering a length of line in his hand Turner gently released the baited hook on the water, the breeze taking it down stream and gradually straightening out the line. Anxiously they watched the 'hopper' float past a bush. Then with a swirl and a suck the bait was drawn under the surface and he was fast into a splendid fish. Fortunately he must have been able to clear the bush and play his fish from the open bank beyond, for it was duly landed and weighed over the pound, a perfect speckled beauty of the variety known as *Salmo fario*, the Brown Trout. Several trout were taken in this manner and thus 'H. G.'s' last visit to these hills must have been all the more memorable for him.

The first Great War which broke out shortly after the last attempt at stocking foredoomed further experiments, but it appears clear that the whole project was now being looked upon as a failure and that the Company were unwilling to continue with it. We find no further references to fish and fishing until the year 1932 when A. W. John of Chittavurrai obtained permission from the Company to undertake experiments on his own account.

III.—RAINBOW TROUT.

The so-called Rainbow Trout of the Nilgiri Hills and Ceylon varies in appearance and habits. Rainbow Trout were first intro-

duced to the British Isles about the year 1900 and were at once hailed with great enthusiasm in angling circles. A few voices were raised in warning, but the success of the fish itself from the sporting point of view silenced all further argument. The Rainbow proved to be a keen feeder, and of extraordinary rapid growth where feed was plentiful, a free riser and game, but with a tendency to stop rising as its weight increased. In the larger fish cannibalistic and migratory tendencies were pronounced.

We have often been asked what happens to our trout in the lochs of the High Range? Let us study the question in the light of experience at home and abroad.

First it must be understood that the Rainbow placed in the same water as his cousin *fario*, will develop at twice *fario's* rate in size and weight. The strong migratory instinct may be partly explained by the fact that, having culled the cream of the feeding from one part of the water in a short space of time, as these voracious fish can do, they move off to another part of stream in search of further well-stocked larders. But what happens to trout placed in a loch or an artificial lake from which there is no outlet? The answer may be found in the following experiences.

A certain lake in a mountainous part of the British Isles, which contained only a few wary char, was stocked with a thousand yearling Rainbows. The lake did not rise much, and as the outlet was small it was easily screened. During the first year the trout were seen rising freely and the general opinion was that though these trout had grown, they were not yet takable. The following June exactly 14 months after they had been liberated, the owner of the lake went down to see if he could land a fish or two, so that he might know how they were getting on. He had no idea in his mind that they would be ready for the basket. There was a fine ripple running over the loch when he arrived, and shifting cloud in the sky, and he soon perceived a rise not far away. At the very first cast he rose and hooked what at once appeared to be a heavy fish. The fish played well for several minutes breaking the water like a sea trout and ripping off many yards of line so that the reel screamed as if a salmon had been hooked in heavy water. When the fish was finally netted it proved to weigh no less than 2 lbs. and within an hour five had been caught the biggest being just under 3 lbs. The news of this great catch travelled far and wide and the experiment was hailed as a wonderful success. Towards the end of the season however the fishing fell off and the following year only a few trout were taken. What had happened? The screen was intact, the loch had never overflowed, and there was no possibility of the fish having departed upstream. They had simply taken to bottom feeding, and the deeper water.

In another instance at home an artificial lake with a bottom outlet, and containing no fish, was stocked. The water was surrounded with trees, and as it was almost stagnant it was deemed advisable to turn in only a few trout. These were never seen again for a year and it was thought that they had died. The water was therefore run off and there were the fish, almost the entire number,

great fat lazy fellows some of 4 pounds, and only two-year old! These experiences bear a strong resemblance to our own trials at Chittavurrai, Loch Finlay and Devicolam, of which we shall now hear more.

A. W. John's Experiments.—In 1932 Mr. John first made a number of small artificial lakes at Chittavurrai, an estate lying on the north-east edge of the Company's concession overlooking the plains of Madura and at an elevation of 6,154'. He had taken advice, sound enough in theory, but incorrect in so far as his particular conditions were concerned. He hoped that his trout might thrive, and even breed in the feeder streams leading into his lakes, but in this he was disappointed. Yearling fry, fingerlings, were brought in fish carriers by lorry from the hatchery at Avalanche on several occasions. Supplies of ice were arranged at various points such as Coimbatore, Pollachi and Udamalpet, and the journey was undertaken at night. It was an arduous task demanding considerable endurance. The latter part of this journey up the narrow winding ghat road to the hills was generally undertaken as dawn began to break, and it was with relief that the cold air of the hills was felt and the back of the journey broken.

Mr. John at first transported a few hundred trout successfully. For 18 months he watched these trout rising freely, and then he allowed a few friends to fish the water. At the first outing five fish weighing $10\frac{1}{2}$ lbs. were caught and throughout the season fish ranging from 2 to 4 lbs. were taken. The second year a fish of $5\frac{1}{2}$ lbs. was caught but thereafter nothing. The lakes were stocked again with similar experiences but the big fish disappeared altogether. These lakes which were, in actual fact, acting as large silt traps, contained, latterly, many feet of thick black mud at the bottom. That the bigger fish died, many of them spawnbound and that they buried themselves in the mud would be a likely explanation for their disappearance.

In spite of the fact that this undertaking had been a failure, Mr. John had stimulated interest again, and our successes of to-day are very largely due to his keenness and determination.

A small Angling Association was now formed which was backed and largely financed by Mr. J. S. B. Wallace, General Manager of the Kanan Devan Hills Company, and the Association set to work and built the second hatchery at Arivikad.

IV.—THE FIRST SUCCESS.

The second hatchery was built and managed by Alasdair Steven but it was dogged by bad luck from the start. The choice of a site was to some extent that of an expert, and while conditions at the time of choosing it seemed suitable enough, it soon transpired that there were many disadvantages, the principle ones being rapid fluctuations in temperature and a water supply subject to muddy spates from the clearings of a neighbouring Estate. The hatching troughs were constructed of wood, later lined with galvanised metal and afterwards concrete. The filters were of cloth, and

worked efficiently. Several importations of eyed ova from the Nilgiri Hills failed, the small fish or alevins of which we shall hear more anon, hatching out almost at once in the apparently too warm water, and, turning up their little tails, dying by the hundred. Some success was achieved from stock fish brought over from the Nilgiris and developed in ponds at Arivikad.

It was at this period that the general atmosphere round angling circles in the High Range became one of despair, and backing fell off almost entirely. The present General Manager of the Kanan Devan Hills Produce Company, Mr. E. H. Francis, was elected Chairman of the Association now consisting of 11 members, and he inaugurated a new idea, called 'The Eruvikulam Policy' and we shall presently hear how from this last despairing attempt, the success of the trout of Travancore, in 1943 became a confirmed and established fact.

While the experiments at Chittavurrai were going on, the loch at Devicolam and Loch Finlay had been stocked through funds raised from private subscriptions from the planters. At Devicolam, which is to some extent a natural loch, but screened and dammed to provide water power for Periakanal Estate, great sport was obtained, but the experiences here were in line with the first of the two home experiments already described. At Loch Finlay one good year's sport was obtained, but here again conditions were similar to those of the second home experiment. These fishing waters however provided sport close to the centre of the district, and so long as the possibility of catching a trout existed there, a few members of the planting community retained interest in the project. Mr. Francis, backed by the Directors of the Company, decided to review the whole position once again, and briefly the conclusions arrived at were these. No natural breeding of Rainbow trout could be expected at an elevation under 6,000'. Artificial lakes and ponds were quite unsuitable for these fish, as the big fish disappeared within the first year or two and many of these probably died spawn-bound. It was thought probable that fish died on reaching an age of approximately 5 years, but information on this point was still being sought. The hatchery site had been unhappily chosen and must be considered a dead loss.

On the credit side, we could turn our eyes to the highlands of Hamilton's Plateau where the Eruvikulam River rises, and there, we were confident, trout would thrive and multiply. Beyond Hamilton's Plateau further magnificent water at Puar and Kalar was clearly indicated on the map, while at Rajamallay Estate a splendid river drains out to the west. The Loch at Devicolam had already proved sufficiently successful to be worth restocking from time to time, and it had always been a great attraction for the residents in and around the town of Munnar.

At the hatchery we had some two hundred fry, and a few yearling trout, which had been earmarked for Eruvikulam. In spite of some opposition, the Committee decided to move these fry during the heavy monsoon of 1937 to Hamilton's Plateau, and liberate them in the headwaters of the Eruvikulam River. At that time there were no roads across the plateau, the last Estate path ending at the edge of

the Upper Vagavurrai Tea Estate, below the 'Knife Back' ridge. From Arivikad the trout were transported by lorry in earthenware pots, and from the Upper Vagavurrai Bungalow by head-load. The expedition, in the height of a heavy monsoon burst, was no mean undertaking, but the fish travelled well, and the porters put up a very fine display of endurance. The expedition was well supplied with rum which put heart into the men for the homeward journey in the evening. Not a single fish was lost during the transport and as the temperature was steadily dropping in the carriers during the whole journey they were liberated almost at once. It was a wonderful sight to see the little chaps wriggle off so fit and well, and to feel that, at all events, the first stocking of this magnificent water had been accomplished. In 1938 Mr. Francis presented 500 fry to the Association for the purpose of further stocking at Eruvikulam. These were brought through from the Nilgiris by one of the hatchery attendants, but, alas, his transport was not carried out with sufficient care. As a result of this a considerable number were lost *en route*, but again head-loads were successfully taken across the plateau and 301 fry were liberated.

In completing our stocking operations on this occasion and returning to the site of our camp, on the spot where the Company has now erected one of their Boundary Inspection Huts, somebody made the suggestion that a cast be made to see if one of the trout of the previous year's stocking could be caught and examined. A rod was put up by the writer, who made a cast with a small 'Watson's Fancy', at the head of the run into the pool now known as 'The General's Pool'. A trout rose at once and was missed but at the second cast it rose again and was hooked. It was a heavy trout but without a great deal of fight and it was soon brought to the bank. Astonished eyes beheld a monster weighing $4\frac{1}{2}$ lbs. a cock Rainbow in perfect condition. This trout, one of 160 liberated the previous year, had put on at least $4\frac{1}{4}$ lbs. in 16 months! This is a typical illustration of what can happen when rainbow trout are liberated in virgin water so full of natural food as was Eruvikulam in those days. The following year Lieut.-General E. F. Norton, C.B., D.S.O., M.C., of Everest fame, his wife and the writer, caught six trout weighing 20 lbs., no less, while Mr. E. H. Francis and the writer have between them caught four or five weighing just under 5 lbs.

Those of you who have read that delightful book by H. R. Jukes, 'Loved River', will remember how they succeeded in hatching out trout in an old perforated steel trunk filled with sand and gravel. From this idea in a slightly elaborated form, experiments were now undertaken. The experiments, which were almost solely governed by the generosity of a few keen fishermen and the Company, had to be conducted upon an economical basis, and in order to lessen transport costs ova was purchased instead of fry. Ova boxes were made approximately the shape of a standard steel trunk, but constructed with a frame work of angle iron to which was fitted very fine perforated zinc sheeting. These boxes were partly filled with gravel and placed at the tail of a run in the main river where the current is slow. The first ova was bought from

the Nilgiris, but this experiment was a complete failure owing to the hatching boxes having been placed in a side stream in the bed of a swamp where dirty water was at once stirred up with the lightest shower of rain. At Christmas 1940, however, a fairly successful experiment was carried out near 'Mackenzie's Old Camp' site and a more successful one in the main river itself, with ova from Ceylon. Some five or six thousand trout were hatched out and liberated, but what was even better, *definite proof* was established that our fish were breeding naturally and several families of young fry were discovered in the headwaters.

It was stated earlier that the question of breeding trout was governed by temperature and that the normal method of sending eyed ova from one place to another is by packing them in moss on trays fitted into a wooden box filled with ice. All that is necessary to do when transporting the box is to make a periodical inspection and fill up with ice, and as most journeys of this kind in South India only necessitate a matter of a few days, the question of picking out dead eggs does not arise. When the ova chest arrives at its destination it is immediately opened and the ice from the top tray removed. A thermometer is then placed in the box which is closed again. The temperature of the water into which it is intended to place the ova is now carefully checked, and after 15 minutes the thermometer in the box is examined. For the sake of argument we will assume that the water temperature reads 56°F. and the temperature inside the ova chest 40°, a difference of 16°F. It is necessary to bring the temperature of the ova chest slowly up to that of the water, and this operation must be carried out with great care and *without hurry or excitement* which are fatal in dealing with any item of hatchery work. A watering can with a fine rose should be kept handy, and periodically a little water poured over the box and on to the top tray. This water gradually seeps down from tray to tray over the moss, and by degrees the temperature will be observed mounting. Sometimes if the attendant is competing against a rising temperature in the stream or hatchery, it may take him up to 12 hours to complete this work, but the rule must always be **THE SLOWER THE BETTER**, because sudden acceleration, or a degree or two difference in temperature when the eggs are planted, may well spell death to thousands of them. When the temperature on the top tray has come up to the required level then work can proceed more quickly. Removing the first tray the moss is lightly picked off, and the eggs, inside a piece of fine cloth or muslin, disclosed. The cloth is carefully lifted and placed in a basin of clean water, and the eggs liberated. Odd bits of dirt and moss will float to the top and these should be skimmed off. The eggs which are a delicate shade of pink have a black spot. This is the eye of the fish, and is the indication that the eggs are ripe. From the basin the eggs are poured gently into the hatching box and distributed over the gravel as evenly as possible. The eggs have a tendency to adhere together and lie in heaps in all little depressions in the gravel. When all the eggs have been placed in the box, the lid is closed and a grass covering placed on top to obscure light. The box should be in complete darkness.

The fish farmer should, from now on, constantly be on his knees in prayer, for, should a sudden spate come down and flood the boxes with dirty water the eggs will die. Dirty water is death to the eggs, but apart from that the sudden rush of heavy water would tend to wash them against the bottom of the box and so damage them.

This system of hatching trout by the box method was further elaborated and carried out with success in 1941 at Rajamallay, in the river close to where the hatchery is situated to-day. The fry from this hatch were taken to Devicolam and Chittavurrai and liberated there. The further purchase of 5,000 ova was made from Ceylon and these eggs were flown over to Trichinopoly and from there brought up by car. Two planters went down to Trichinopoly to meet the plane. All went well until leaving for home, when the car broke down. It was found that the car could not be repaired that day, and so while one of the planters stayed in charge the other proceeded by train with the ova chest. But further troubles were still in store, and at Dindigul the train to Udamalpet, the station nearest to the High Range, was missed. After much difficulty a car was hired to go to Udamalpet whither another private car had been summoned by telegram. The eggs arrived a day late with just sufficient ice in hand. About 2,000 fry were finally hatched out by the River Box Method, and taking everything into consideration this appeared, at the time, quite a satisfactory result.

The position then towards the end of 1941 was that a very fair degree of success had been achieved at Eruvikulam, a few thousand fry having been liberated there, fully stocking the river. Two hundred had also been taken below the falls into Turner's Valley. The Devicolam Loch had been stocked again with a thousand fry, and a few hundred had been liberated in the lake at Chittavurrai. The promise of some good fishing the following year was assured, but the membership of the Association had dwindled to 7!

While the waters in the Eruvikulam area had proved suitable breeding streams, it was felt that without a proper hatchery nearer home, waters such as Devicolam, Kanniamallay, Loch Finlay and Rajamallay, could not be stocked and maintained. With encouragement from Mr. Francis, and backing from the Directors of the Company, it was decided therefore to attempt the construction of a hatchery once more, this time on Rajamallay Estate, and the work was commenced on 1st August 1941.

V.—HATCHERY CONSTRUCTION AND MANAGEMENT.

The choice of a site for a hatchery is dependent upon an adequate supply of water from an uncontaminated source, which can be guaranteed to flow at a low temperature during the hatching months. This condition would of course be best realised if a suitable rock or ground spring could be found and such a place would be ideal for the erection of a hatchery. The source of a river, or close to the source of a river and beyond all cultivation, would also be appropriate, but here care should be taken to choose the correct

point from which to lead off the water. A good position to 'tap' a stream would be at a fall or cascade, or immediately below it, where the water would be well charged with oxygen, but in most cases where water is taken direct from a river it is necessary to make one or two silt traps or settling tanks in the water course to obviate trouble from sediment.

At Rajamallay the intake was chosen near the bottom of a cascade about one mile below the actual source of the river and above the cultivation. The water is led into the hatchery through earthenware pipes, and over a series of silt traps, and it has been found that during the hatching months the temperature of the water in the hatchery itself never exceeds 58°F. while in the early mornings it is often as low as 48°. For the breeding of trout these figures have proved very satisfactory but it is thought that anything over 60° approaches danger mark for the hatching of ova. Our hatching period is generally between November and the middle of January when there are often very severe frosts at Rajamallay particularly in the vicinity of the hatchery. The mean reading during the season 1942 was 55° at the hatchery, which is suitable for Rainbows but on the high side for Brown Trout.

Adequate aeration is not entirely governed by the nature of the water. Temperature is also an important factor, for it has been shown that the lower the temperature the higher will be the oxygen content. As temperatures in the South Indian Hills are on the high side, it is therefore all the more essential that the intake for a hatchery should be from high falls and rough water to compensate as much as possible for the higher temperatures expected.

Having satisfied ourselves that our water supply and temperatures are efficient, we next turn to material for the construction of our building, bearing in mind that the two greatest enemies we have to defeat are SEDIMENT and FUNGUS. The former can only be overcome by a perfect system of filtration, while defence against the latter is plain CLEANLINESS.

In England hatching troughs were at first made of wood. Disease from a fungus of a kind thriving on wood lying under water frequently developed and large hatches of ova were lost. The signs of this are that the eggs appear slimy, sodden and lifeless, and that they exude millions of small hairs which break off, and floating down the water infect all eggs with which they come in contact. An improvement on the wooden hatching trough was made by charring and varnishing the timber, but in the East, where the dangers of fungus are even greater due to the warmer water, tar was applied, though Mr. Philip Fowke who has described this in his excellent book *Trout Culture in Ceylon*, states that this further precaution is insufficient to guarantee immunity. Acting upon Mr. Fowke's advice the troughs at Rajamallay were constructed of reinforced concrete.

The head tank of the hatchery measures 3' × 3' × 3' and is fed through earthenware and concrete pipes for a distance of 400' from the main river. The water from the head tank is controlled by a wheel valve which supplies the distributing trough the dimensions of which are 11' × 15" × 15". The water from the distributing

trough is controlled and distributed into two filters. These filters have eight partitions through which the water must travel. Provided the sand and gravel in these filters is of the correct consistency no clogging will take place from sudden spates and silt deposit, during the hatching months. This point must receive very careful attention each year. The hatching troughs are $10' \times 2\frac{1}{2}' \times 1'$ which gives sufficient space for about 50,000 eggs provided glass grilles are used. The ideal method of hatching out ova is on glass grilles.

We have already described at some length how to deal with imported eyed ova, so let us now turn to the question of our own ova and how we must obtain it and hatch it out.

In the first place we are told the progeny of pond fish are never so strong and hardy as that of wild ones. While this is partly true it is not always possible in the early stages of such a project as ours, to obtain the eggs of wild fish, and a makeshift arrangement for taking the ova of pond fish becomes necessary.

Stripping.—The pond spawners usually commence running up the channels at the end of November, but in 1942 only a small proportion of the fish from which we had hoped to obtain eggs, came up the run. A modicum of success was obtained and the first Rajamallay Trout were hatched out on the 31st December of that year. These trout, about 600 of them, did very well and developed into strong sturdy fish.

The ideal method of stripping has been dealt with many times in books on the subject, such as Mr. Fowke's work referred to earlier. Briefly the system is as follows:—When the trout first begin to run and show signs that spawning is near, it becomes necessary to make an occasional examination of the fish. The run is screened above and below and the fish netted and placed in a bath filled with river water. In handling fish the utmost care must be exercised to avoid removing scales which is apt to cause fungus. It is recommended that wet gloves or a wet towel be used. The fish should be gripped firmly with the right hand above the tail, and gently above the shoulder with the left. The slightest pressure with the left hand down the back is sufficient to start the eggs flowing if the hen is ripe, but if the eggs do not flow she should at once be returned to the water. On no account should eggs be forced from a fish. To facilitate the work the male fish should be kept in a separate bath and the minute the eggs of the female have been stripped into a *dry* basin, a male is taken and similarly the milt expressed on to the eggs. The process should be undertaken slowly and deliberately remembering that it is possible to keep a fish out of water for at least a minute. Difficulty is often found in obtaining sufficient milt. Mr. Fowke recommends the use of as much milt as possible, and if the male refuses to part with his milt the immersion of the fish in a pail of warm water will relax his organs. We have found at Rajamallay that by touching the vent of the cock fish on the eggs a good flow of milt can be obtained. Very little practice is required to differentiate between the sexes, the head and shape of the mouth in the male fish being distinctive. The fish should all be stripped in rotation into the same basin, tilting the basin from time to time thus mixing the eggs and milt together. Five minutes after the last fish

has been stripped pour cold water over the eggs and place the basin in a shady place. Tilt the basin every five minutes until the eggs tend to separate and float. They should then be rinsed with cold water several times until the dead milt has all been removed when the eggs are ready for the hatchery. The actual stripping is called the *Dry* method but inevitably a certain amount of water is spilled into the basin during the process. However keep the operation as *dry as possible* until the fertilisation has been completed. The eggs are now gently poured into a jug of cold clean water and taken to the hatchery. In 1943, 14,000 ova from pond and wild spawners were taken and 70% were hatched out successfully.

Grilles versus *Gravel*.—The floors of the hatching troughs at Rajamallay are usually covered with fine carefully washed gravel. This is undesirable, but is the only alternative to glass grilles known at present. Glass grilles are unobtainable in war time and those in our possession, which were sent over from the old hatchery at Arivikad, are insufficient for our purpose. The eggs however which are hatched on glass grilles are better in every way and a much higher percentage of success is obtained with them. The case for and against is very well set out by J. J. Armithead in his *Handy Guide to Fish Culture*, written in 1890. The main points are:—

GRILLES

1. Sediment goes to the bottom and the eggs are kept clean.
2. Deposit resting on the eggs can be easily removed.
3. Destructive insects easily detected and removed.
4. Dead eggs easily detected and removed.
5. Water flows under, over and round the eggs, which thus obtain the maximum amount of benefit.
6. Fungus easily detected and removed.
7. The grilles can be lifted out before the eggs hatch, and the bottom of the trough cleaned.
8. The eggs can be accurately counted.

GRAVEL

1. Sediment goes to the bottom and the eggs are in close contact with an accumulating mass of filth.
2. Such a deposit cannot be removed without stirring up more filth thus making matters worse.
3. Insects cannot be detected hidden as they are amongst the gravel.
4. Dead eggs may remain hidden for days infecting others.
5. Eggs do not get full benefit from the flow of water and the mortality is higher.
6. Fungus could thrive undetected amongst the gravel.
7. The gravel cannot be removed until the fry have hatched out.
8. The eggs cannot be counted easily or without disturbing them.

It follows therefore that at Rajamallay glass grilles will be used exclusively as soon as they can be purchased in sufficient quantity.

Having stripped our eggs and taken them to the hatchery as already described, they are poured gently on to the grilles, or gravel, and developments are awaited. During this period the eggs are in a very delicate condition and great care and attention must be exercised by the attendant. They should not be moved in any way and examined only very occasionally. At Rajamallay the troughs are covered with wooden frames to which is tacked dark blue veiling which, while excluding light, yet admits sufficient air,

The Hatch.—About the fourteenth or fifteenth day an egg with an eye is observed and a few days later the whole lot have the eye of the embryo fish in evidence. The eggs are now 'eyed' or fertile and are strong enough to stand handling. It is in this state that they are shipped from home to many parts of the world. About the 28th day the eggs begin to hatch. The egg cases split, tails appear, and then with much wriggling and struggling minute fish, queer looking freaks, emerge and drop to the floor of the hatching trough exhausted. The 'alevins' as these are called tend to lie huddled together in all corners or crevices concealed from light. Trout have no eyelids and to them light is painful and distressing. Their protection in this respect is of great importance in this country. When all the alevins have hatched out the egg shells must be cleared. This can be done by increasing the flow of the water from the filter troughs and collecting the shells when they gather on the screen at the outlet. Nature provides the newly born fish with a yolk sac on which they exist for the first days of their life. This sac is gradually absorbed and now the alevins must be fed.

Alevins.—In the alevin stage the hatchery probably requires less attention than at any other time, but it is necessary to see that all possible crevices or flaws in the hatching troughs are filled up, for any possible exit will soon be discovered. The alevins may well be described as a 'suicide squad' for in their efforts to hide they will endeavour to bury themselves in the smallest cracks in the structure of the trough. Some years ago we were conducting an experiment with hatching boxes in the river at Eruvikulam. The boxes had been very carefully made, the corners and bends in the sheeting having received special reinforcement. A good hatch had been obtained from the ova and all the boxes were full of splendid little alevins. Owing to pressure of work the boxes had not been visited for some days, and our attendants, alas, lacked powers of observation. When we arrived on the scene of action we were greeted with smiles and the news that 'all was well'. On looking into one of the boxes however, we were horror-struck to find that about half the alevins had disappeared. The attendant was adamant that the box was exactly as when last inspected, but a careful examination revealed the tiniest crack in the zinc sheeting through which it would seem that nothing could have escaped. However it was indeed through this crack that some several hundreds had made their escape, because we watched it happening then and there, and later found a few of the alevins in the bed of the stream. In the same way numerous fry were lost, shortly after they had commenced swimming, from a small earth pond the sides of which had been inefficiently plastered. To be absolutely safe hatching troughs should be of concrete or glazed tiles, and the first fry ponds or grading ponds as they are called, made of carefully plastered concrete.

After a few days the alevins will not 'pack' so much together, and will begin to dart about and swim. At this stage the filters can be removed one by one, *for now the sediment so dangerous to the ova is food for the rapidly developing fry.* Then comes the great day when arriving at the hatchery we lift off the covers to find a swarm of healthy fry battling against the current at the head of the trough.

Fry.—Our hatch has been a success, and we experience a not unnatural glow of satisfaction and a feeling of pride in our achievement. But it is no time to sit back and take things easy. Many fish farmers look upon this as perhaps the most important time of all, for the fry must be fed. Four times a day the yolk of a hard boiled egg is squeezed through a handkerchief and sent down the stream in a cloud. The fry dart at it continuously and from day to day we watch them steadily improving in size and condition. Mr. Fowke in his book lays down that the Golden Rule in feeding fry is a LITTLE AND OFTEN. As the fry develop the size of the feed is increased, and now we feed them, still with the yolk of egg, but administered through an ordinary tea strainer. Care must be taken to avoid administering food too large, or the fry will choke.

Feeding.—Next we augment the diet with a fine liver mince, with which we continue until the time comes for the fry to be removed to the grading ponds. Now comes the question of HOW MUCH food to give the fry. A Head Keeper from Aberdeenshire stated that he always found this question difficult, and he could not judge the proper amount to give them, but recommended putting half the hatch in a slow running stream to find food for themselves. However it is impossible to overfeed fry and it is therefore better to err on the generous side. There are four grading ponds at Rajamallay and here the fry remain until they are big enough for the stew ponds. The necessity for grading ponds is on account of the divergence in the growth of fry usually experienced and also on account of the fact that the fish should be introduced to depth of water by slow stages. The diet has been steadily increased and now pastes made from vegetables, dried fish and meat are given. The greatest care must be exercised in regard to feeding hatchery trout. In the early stages the administration of the yolk of eggs and liver mince presents little or no difficulty but as the fry develop and increase in size our food bills mount accordingly. The result is that we are tempted to explore methods of economy which to the uninitiated may well spell disaster. Under the paragraph on diseases a good example of the kind of thing that can easily occur is given. We find that the best possible feed for developing fry from the six month to the yearling stage is beef or mutton chopped, and passed once through the mincing machine. This is mixed together with carrots, peas, beans, cabbage or potato which have been well cooked. The peas and beans should be soaked for 24 hours and then boiled for four hours, which ensures the food being soft. Any sudden change to a hard diet is apt to injure the stomach walls. Liver, dog biscuits offer an useful variation.

In the High Range the pink flesh of the trout proves that the water is prolific in shrimps. If these are caught they present the perfect food for trout. Termites have been offered to fry on numerous occasions with success.

A year later the fish are sturdy little chaps many of them 6" in length and ready for their final journey to the rivers and lochs where they must look after themselves avoiding, if they can, the Silver Doctors, and Teal and Reds which seem to appear so regularly at Week-ends!

Diet.—In feeding fry it must be remembered that a wholly meat diet is detrimental to female fish, diseased ovaries being the almost certain result. A balanced diet is essential, in which vegetable foods should play a prominent part. In *Fish Farming for Pleasure and Profit* by 'Practical' much useful information on this subject has been laid down but it has been found difficult in Travancore to follow the ideals set forth, such pastes as the author recommends being unavailable.

Natural Food of Trout.—The Eruvikulam and, indeed, all our streams were, before the advent of the Rainbow, full of a small indigenous fish known locally as 'Kal meen' *Glythroax Madraspatnus* (Day). It is now nearly a year since we saw 'Kal meen' in number at Eruvikulam or Turner's Valley and so we can safely assume that these small fish present a very desirable item on the Rainbows menu.

Fresh water crabs, beetles and molluscs of all kinds are prolific in our streams, but these too are rapidly disappearing at Eruvikulam, where much harm has been done by overstocking.

Hatches of fly resembling familiar members of the Ephemerae, such as the Blue Dun have been seen at Eruvikulam, while at Rajamallay caddis flies (*Trichoptera*) have been frequently noticed. The most common rise however seems to be to a small black midge of the Diptera order. It would be of invaluable assistance to us in our work if all anglers took a keen interest in insect entomology and sent in their reports. Much study is required, and a typical High Range stream on Rajamallay Tea Estate has been left unstocked for observation purposes.

Experiments with the production of water fleas and such animals, which are collectively known as plankton, by means of artificial ponds, the bottoms of which have been covered with manure, are being undertaken. The principle is that the nutrient matter derived from the manure will, if exposed to light, grow an enormous quantity of minute green plants which is the food of plankton animals. Given such conditions plankton will increase with amazing rapidity and can be used as food for fry. Snail beds are being put down at Rajamallay and also the dams and deflectors now being made in the upper waters are bound to have a beneficial effect on food conservation generally.

It is necessary to reiterate the word *cleanliness* when dealing with fry in the hatchery. The scrupulous cleanliness of the hatching troughs is more than ever essential, because fry are subject to sickness and disease. At Rajamallay the fry are changed from one trough to another weekly, and the sand and gravel replaced with a fresh supply, a stock of which is kept ready and washed outside. There is a simple tonic for fry if weakness of any sort is discovered. A paste of mud from the underside of a turf is released at the inlet and as the mud cloud filters through the water the fry are seen darting here and there to avoid it. Finally when the cloud clears the fry are seen darting about fresh and invigorated. At Rajamallay we give a dose of this earthy water as a matter of routine. This tonic was first described many years ago by the well-known fish culturist, Livingstone Stone. Mr. Fowke mentions nibbling a very irritating habit in which

fry indulge. They nibble the tails of their fellows which then become liable to fungus. Strangely enough we have not so far come across this distressing vice at Rajamallay, but nevertheless we are taking care to spread out the fry as much as possible, and attend to grading and regular feeding.

To sum up, the two most important factors in hatchery work are:

1. *Caution*, do not hurry but take things slowly and deliberately, and
2. *Cleanliness*. These are golden rules which will repay a thousand-fold if carefully followed.

Deformed Fry.—Deformed or twisted fry are, alas, common in a hatchery. There may be several reasons for this, but it is probable that some accident occurred such as the egg being knocked against a stone, or in the effort of breaking forth from the egg, perhaps, a little spine may have become damaged, so that we find fry with twisted backs, or peculiarly shaped heads, swimming about with the others. Siamise twins are by no means uncommon, but we have never succeeded in keeping these alive for any length of time at Rajamallay. We think it is rather cruel to keep these little deformities alive at all, and only the most vigorous ones are liberated in our stream. From June 1941 to January 1945, approximately 36,000 perfect trout were hatched at Rajamallay.

Diseases of Trout.—At Rajamallay no sign of disease of any kind crept in until 1943. One day however we noticed several of the yearlings making for the still water, turning over and over, and in one case a fish had fallen to the bottom. Mr. Fowke in his book stresses the appalling nature of a disease called *GYRODACTYLUS* which is very infectious. The cause is dirt, and the remedy, to remove all the fish to clean water and thoroughly clean out and lime the pond. It was found that the attendant had been careless and omitted to clean the pond daily as a matter of routine. Fortunately for us there was no recurrence of this disease. Another fish was found to be suffering from *BLACK OPHTHALMIA*, an eye affection. The symptoms are that the fish turns almost jet black in colour. The cause of the disease is said to be unknown, and it is not infectious.

During 1943 the vexed question of the cost of fish food led to a minor disaster. *KOONIES*, a type of small dried prawn readily available at a cheap rate, were being administered together with such vegetables as were available during the monsoon. One morning the hatchery attendant reported that the fry were looking 'off colour' and tending to fall back to the outlet end of the pond, where the current is slow. This is generally a sign that fish are weak, and on examination it was found that many were lying at the bottom and dying in some numbers. All the usual first aid precautions were taken. The fry were moved to a spare tank supplied by water from a fresh source, and used for just such an emergency. The feeding was stopped for a day and the old tank cleaned and limed. Things seemed to be better a day later, but deaths now began to occur amongst yearling trout. It was then discovered that the 'Koonies' being given were very old and smelling badly, and further that much of it was rotting in the tanks, which had not been properly cleaned. The stomachs of many fry were cut open and carefully examined and